Metrozet STS1-E300
STS-1 Very Broadband Seismometer Electronics

Triaxial Replacement Electronics with Analog Performance Equivalent to Original STS-1 Feedback Box

Replaces up to 3 original "feedback electronics" boxes

Network-Compatible Control and Monitoring of Operating Parameters:

Remote control of sensor response (360sec/10 sec. Damping IN/OUT)
Remote motor operation and one-step "Auto Center"
Automated calibration functions with internal signal generator
Digitizer for remote observation of critical state-of-health parameters

Fully-hermetic package and cabling

Metrozet's STS1-E300 is an advanced electronics package that provides a modern replacement for the original Streckeisen "Feedback Electronics" boxes. It matches the outstanding analog performance of the existing circuitry, while providing a number of enhancements that make installation and operation of the sensors more efficient, within a modern seismic network. These include digital control of all sensor parameters (corner frequency and damping, with a new 10 second setup mode), remote digital control of centering motor operations (including a new, one-step "Auto Center" capability), and a digitally-controlled diagnostic function that allows remote monitoring of all major instrument state-of-health parameters (including critical power supply voltages, boom position, signal output levels, motor switch state, electronics temperature, and a number of auxiliary, analog and digital input lines). All of the control and diagnostic functions can be controlled locally (via RS-232, USB, or Ethernet), or remotely (via Ethernet).

In addition, the STS1-E300 provides a complete calibration capability that includes on-board generation of velocity or acceleration-equivalent test signals (step, swept-sine, and fixed-frequency sine) as well as automatic switching of calibration test signals into the standard output signal connectors ("Auto CAL"). The latter feature eliminates the need for a separate "calibration signal" recording channel, thus allowing recording of transfer function measurement data, from triaxial sensors, ***within a three channel data acquisition system.*** The system also maintains the existing capability for injection of user-generated, external calibration signals into the system, through a dedicated connector.

All of the control, diagnostic, and calibration features are implemented in an ultra-reliable, "fail-safe" manner. The system is automatically re-configured to operate as a strictly analog sensor, following power-on-reset, or after a pre-determined time without an external command.

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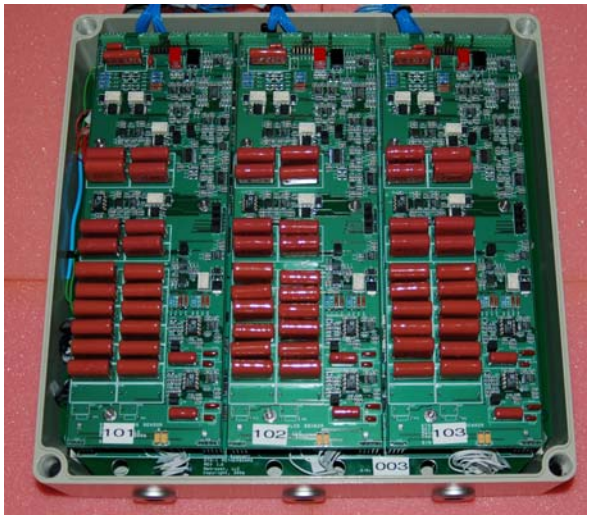
The STS1-E300 provides a capability for operation and control of three STS-1 sensors. Single and dual-axis versions are also available. This new module improves greatly on packaging, relative to the original electronics. A fully watertight case, along with gastight connectors and cabling, is designed to eliminate a number of moisture-related effects that have plagued the worldwide fleet of STS-1 sensors.[1][2] Metrozet offers cabling with all critical signals distributed within a twisted-pair configuration. Specifically, Metrozet's hermetic sensor cable, which is fully-compatible with existing the STS-1 baseplate connector, utilizes a twisted pair configuration for all low-level differential signals. Note that the original, non-hermetic "orange" cables from Streckeisen do not.

Each STS1-E300 module is trimmed to provide identical performance on any given STS-1 mechanical sensor. In this way, the electronics are interchangeable between sensors. The exact scalar responsivity of the sensor can be calculated using the "Metrozet STS1Scale Factor Calculator V1.20" software applet that is included with the electronics.

In short, the STS1-E300 provides STS-1 users with an improved, and fully-supported, capability for extending the operating lifetime of the world's highest performance, broadband seismometers.

Supporting products are also available. These include Metrozet's External Power and Telemetry Module (STS1-PTM1), as well as standard and custom cabling. Also, Metrozet will be providing a soon-to-be released software module (STS1-CALEX-EW) for performing automatic frequency response calculations using general calibration signals (including step and sweep signals internal to the STS1-E300)[3]. This software will analyze recorded data stored in standard seismic formats, and it will automatically compute poles and zeros of the complete STS-1 sensor.

Please contact Metrozet if you have any specific questions or requirements.



Internal view of STS1-E300 triaxial electronics. Three, complete analog sensor feedback circuits are shown. They are integrated with an underlying motherboard that provides power regulation and stabilization, digital motor control, calibration signal generation and signal conditioning, diagnostic signal recording, and remote communication. SENSOR cables (E, N, and Z) attach to the side of the box facing the top of the picture. Respective SIGNAL output cables are attached to connectors shown at the bottom of the picture. CAL and CONTROL cables attach to the left side of the box, near the top and bottom of the picture, respectively.

[1] Ekström, G. and Nettles, M., 2005: http://www.seismology.harvard.edu/~ekstrom/Projects/WQC.html.

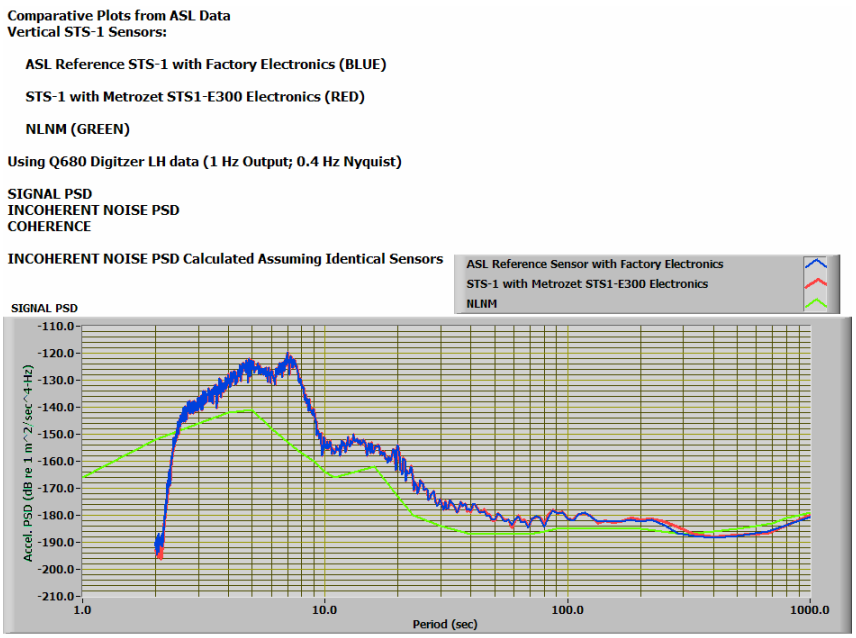
[2] Yuki, Y. and Ishihara Y., Methods for maintaining the performance of STS-l seismometer, *Frontier Research on Earth Evolution*, **2**,1-3 (2002).

[3] Based upon conjugate gradient filter methodology developed by Professor Erhard Wielandt, University of Stuttgart.

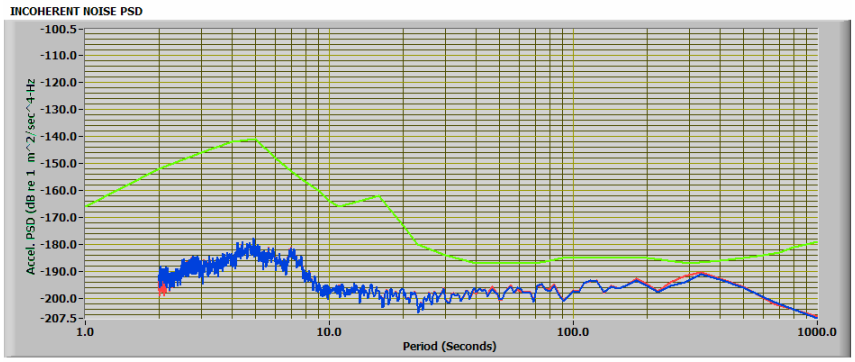
Analog Performance Equivalent to Existing STS-1 Feedback Electronics

Two co-located sensors at USGS Albuquerque Seismological Laboratory (USGS/ASL)
Blue: Metrozet STS1-E300 Connected to STS-1 Mechanical Sensor S/N 38502 (Z)
Red: ASL Reference Sensor: Original Factory Sensor with Factory Electronics
Power Spectral Density (PSD) Units are Velocity (dB re 1 mRMS/sec-rtHz)

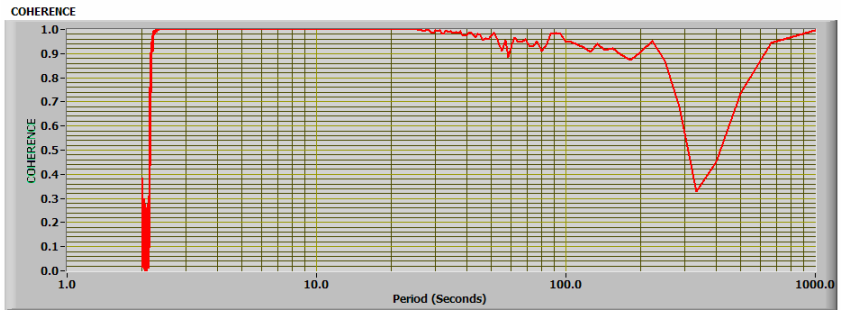
Ambient Signal PSD, Incoherent Noise PSD, and Coherence (1 Hz Sample Rate)



Signal PSD from STS-1 with Metrozet STS1-E300 Electronics is equivalent or lower than STS-1 with original electronics

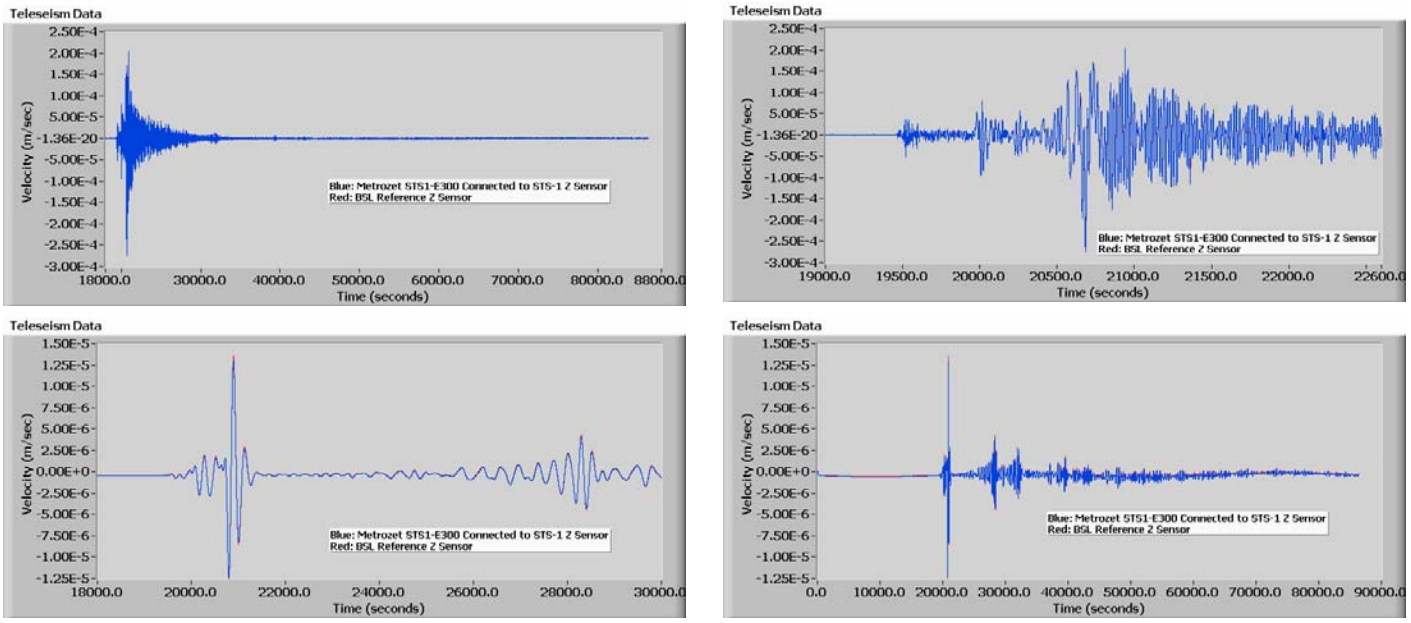


Incoherent Noise PSD from STS-1 with Metrozet STS1-E300 Electronics is equivalent or lower than STS-1 with original electronics



Coherence is used to convert between Signal PSD and Incoherent Noise PSD.

Teleseism Recording (M8.3, Kuril Islands, November 15, 2006)
(Use browser zoom function to distinguish individual traces).



Teleseism Data from M8.3 Event from Two Co-located Sensors: Clockwise from Upper Left: a) 70,000 second record at 0.4 Hz bandwidth. b) zoom view of onset with 0.4 Hz bandwidth. c) 90,000 second record at 0.005 Hz bandwidth; note underlying tide signals. d) zoom view of onset at 0.005 Hz bandwidth.

Metrozet STS1-E300: Detailed Specifications

Specification	Value
Format	Electronics supports up to 3 fully-independent sensor channels Nominally configured as E, N, and Z. Single and dual-axis versions available
Nominal Low Corner Frequencies	360 seconds, Normal Operation 10 Seconds, Setup Nominal Damping: 0.707 of critical
Analog Output Ranges	Approximately +/-23V Differential for BRB and LP Approximately +/-11.5V Single-Ended for Boom Position
Uniformity	Exchange of electronics boxes will maintain corner frequency, damping, and scalar responsivity, to within 1%
Sensor Control Functions	*Via serial command strings:* Independent control of each sensor's low corner frequency: 360 sec Default, 10 sec in Setup Mode Independent control of each sensor's low corner frequency damping: 0.707 of critical Default, undamped in Setup Mode
Motor Control Functions	*Via serial command strings:* Independent monitoring of each sensor's motor limit switch Independent control of each sensor's centering motor: ON/OFF/Direction One-step "Auto Center" for each sensor *Works seamlessly with both horizontal and vertical STS-1 sensors*
Calibration Functions	*Via serial command strings:* Direct connection of external signals to sensor CAL coils Signal conditioning circuitry for converting raw CAL signals into acceleration or velocity-equivalent stimuli External input of remote CAL signals into signal conditioning circuit Internal generation of CAL signals via 16-bit DAC Internally-generated step, sine sweep, and sine (0.01 Hz, 0.1 Hz, and 1 Hz) Optional "Auto CAL" function: CAL Stimulus connected to E SIGNAL connector E or N sensor output connected to N SIGNAL connector Z sensor output connected to Z SIGNAL connector
Diagnostic Functions	*Via serial command strings:* Digitization of internal signals via 24-bit ADC (remote diagnostics) Connection of internal signals to analog differential output lines (local diagnostics) Signals Monitored: E/N/Z BRB+/- E/N/Z LP+/- E/N/Z Boom Position E/N/Z Motor Limit Switch State Analog Power +/- (regulated power used by sensors) Input Power +/- Module Temperature (via internal temperature sensor) DAC Voltage Auxiliary Analog Input 0 and 1

	Auxiliary Digital Input 0 and 1
Fail-Safe Mode	All sensors set to 360 second corner frequency, with damping engaged All motor, calibration, and diagnostic functions disconnected from sensor electronics Fail-safe entered upon power-up (or power reset), after 3600 second inactivity timeout, or via remote command
Native Command Interface	RS-232, 9600 baud
Connector Names (quantity) and Functions	SIGNAL (3) Individual signal output connectors for E, N, and Z sensors Differential BRB and LP signals, Single-ended boom position SENSOR (3): Individual connectors for each sensor Analog sensor signals and digital motor control signals CAL(1): Differential external calibration signal inputs and internal calibration signal outputs CONTROL(1): Power inputs, RS-232, analog output of selected internal signals, Auxiliary analog inputs, and auxiliary digital inputs
Connector Types	All are Fischer Connectors, Series DBPE105, fully hermetic bulkhead receptacles: SIGNAL: DBPE105A062-130, 10-contact SENSOR: DBPE105Z102-130, 27-contact CAL: DBPE105Z062-130, 10-contact CONTROL: DBPE105Z038-130, 18-contact
Standard Cabling	SIGNAL: S105A062-130+ on polyurethane cable (4-twisted pairs with shield), pigtailed SENSOR: S105Z102-130+ on polyurethane cable (8-twisted pairs with shield), terminated with S105A038-130+ (standard baseplate connector on STS-1) CAL: S105Z062-130+ on polyurethane cable (4-twisted pairs with shield), pigtailed CONTROL: S105Z038-130+ on polyurethane cable (9-twisted pairs with shield), pigtailed Standard cable length: 20 feet
Input Power	+/-15V nominal; +/-13V to +/-16V Limits +/-250 mA nominal, with power stabilization enabled +160/-145 mA nominal, without power stabilization enabled 10-33V input (reverse-polarity protection, overvoltage protection, and fusing) available with Metrozet's External Power and Telemetry Module (STS1-PTM1)
Power Stabilization	Automatic load current stabilization circuit provides for constant power dissipation within the package
Physical	Package Size: 12.6" x 12.6"x 4.8" (32 cm x 32 cm x 12.2 cm) Weight:17 pounds (7.7 kg)

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